



**UNIVERSITY OF NAIROBI**  
**SCHOOL OF COMPUTING AND INFORMATICS**

**Project Title:**

**Application of a Management Information System in Management  
of Malnutrition Programs, a case study of Refugee Children living  
in Kenya**

**By**

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## **DECLARATION**

This project, as presented on this report is my original work and to the best of my knowledge has not been presented for any other university award.

Signed:..... Date:.....

**Winfred Wambui Kariuki, P58/70469/2008**

This research has been submitted as part of fulfillment of the requirements for the award of Masters of Science in Computer Science of the School of Computing and Informatics of the University of Nairobi, with my approval as supervisor.

Signed:..... Date:.....

**Dr Christopher Chepken**

## **ABSTRACT**

Persons who flee their country of origin because of war, famine or discrimination experience malnutrition due to lack of access to healthy food or/and water during flight or after arrival at the country where they have sought asylum. A majority of people who flee for safety are usually women and children. Children are mostly affected by malnutrition.

Data collection is a key activity for organizations that are involved in malnutrition management programs. In the current setting there is heavy reliance on manual registers for collecting data from the children affected by malnutrition. This has proven cumbersome and time consuming particularly for organizations that are involved in data collections. The teams involved in this processes have to spare time to do data entry and later data analysis in order to come up with meaningful data for decision support. This also causes delays and duplication of effort in managing malnutrition related functions. This can be reduced by implementing a comprehensive Management Information system which would support the decision making process in the whole lifecycle of malnutrition management. This would also enable real-time recording and analyzing of malnutrition related data by all partners involved in malnutrition management which would in turn support faster and efficient decision making, thus leading to better service delivery.

This research project focused on finding out how a Malnutrition Management Information System can be applied in management of malnutrition related activities on a real-time basis. The information system would allow access to common platforms where all actors in the malnutrition management program can update and share information to support decision making.

Part of the research was to design a prototype to demonstrate how a Management Information System would be used to enhance malnutrition management. The prototype comprised of a mobile application which would be used to collect data during routine monitoring of the affected population and a web based system which would be used to manage the resources in the malnutrition management programs. These applications were interconnected to enable real time update of data and enhance monitoring and evaluation. An evaluation was done to demonstrate efficiency of a malnutrition management information system platform. The outcome of the evaluation indicated that the platform would be efficient in managing malnutrition as long as the

appropriate technology and proper training was applied when implementing the system. The prototype would also be scalable in case there was increase in affected population.

## **ACKNOWLEDGEMENT**

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## **CHAPTER ONE**

### **1. INTRODUCTION**

Persons who flee their country of origin because of war, famine or discrimination experience malnutrition due to lack of access to healthy food or/and water during flight or after arrival at the country where they have sought asylum. A majority of people who flee for safety in many circumstances are usually women and children. Children are mostly affected by malnutrition.

**Malnutrition** (bad nutrition) is a state in which physical function of the body is impaired to a point that one cannot maintain bodily performance process such as growth, physical work and resisting disease. The World Health Organization estimates that approximately 150 million – 26.7 percent – of children under five years in developing countries are underweight. An additional 200 million have stunted growth due to poor nutrition. Malnutrition has heavy impact on refugees because they are less engaged in income generating activities or are not at all engaged in any form of economic activities which can boost their ability to access proper nutrition. Developing countries holds a high percentage of people who have been displaced and forced to seek asylum in countries other than their country of origin.

Malnutrition status is normally assessed using measurement of body parameters (**Anthropometric Indices**) of the affected person; example **Weight-for-height** (also referred to protein-energy status) is applied to determine whether the individual has **acute malnutrition**. To assess the changes in nutrition levels periodic assessment is done on the affected population.

**Malnutrition management** in refugee camps involves identifying persons/ populations affected by malnutrition, providing them with suitable nutrition supplements and monitoring their progress and response towards the malnutrition control programs. Once persons suffering from malnutrition have recovered, they exit the malnutrition program. The time of exit is determined by the health/ social worker responsible for the affected person. Monitoring for each person is carried out for 3 months as long as the malnourished person has not shown signs of recovery.

Each week, the health worker goes door to door recording the malnutrition indicators for affected population as part of the monitoring process.

Stakeholders in the refugee and refugee health sectors are all involved in the process of managing malnutrition programs. Malnutrition trend analysis is regularly done in refugee camps to determine malnutrition trends in the refugee population. This analysis is done based on information collected during surveys.

Importance of managing malnutrition trends in a refugee population.

- Sometimes malnutrition is associated with the presence of communicable diseases in the affected persons/population and therefore the need to monitor malnutrition in this population.
- Malnutrition management is important in defining emergency levels in refugee situations in order to justify initiation or suspension of nutrition programs.
- It is possible to identify individuals suffering malnutrition and monitor their progress and response towards malnutrition intervention.
- Nutrient supplements can sometimes be very expensive to provide due to the cost of these products; it is necessary to continuously assess the malnutrition trends of the affected population in order to use this information when budgeting for such products.

### **1.1 Problem Definition**

There are several specialist organizations which are involved in providing malnutrition management services in refugee population depending on the specific malnutrition services that are required to serve the need of that population. These organizations include: social affairs related organizations, clinical related organizations, governments, refugee affairs organizations, food programs, children welfare organizations.

In the current setting all actors mentioned above depend on independent structures to manage malnutrition functions based on their area of specialization. Each organization collects, analyzes and utilizes data based on its needs and without integrating or dependency on elements of malnutrition that are managed by other specialist agencies. It is a common practice that organizations only request or avail information to partner organizations in instances where there is common dependency between the specialist organizations that are involved in malnutrition management. This has created a shortfall in the management of Malnutrition programs since sometime information that could have been useful to one organization was not properly shared thus eliminating the opportunity for service delivery. There is also instances where some organizations have analyzes and acts on information without putting into consideration the impact of their action on the needs of other specialize organization which in turn has created contradiction in service delivery in the general population.

Data collection is a key activity for organizations that are involved in malnutrition management programs. In the current setting there is heavy reliance on manual registers for collecting data from the children affected by malnutrition. This has proven cumbersome and time consuming particularly for organizations that are involved in data collections. The teams involved in this processes have to spare time to do data entry and later data analysis in order to come up with meaningful data for decision support.

**Problem statement:** The current process of recording and analyzing data in regard to malnutrition management depends on a decentralized and multilayered repetitive cycle which delays and cause duplication of effort in managing malnutrition related functions. This can be reduced by implementing a comprehensive Management Information system which would support the decision making process in the whole lifecycle of malnutrition management to enable real-time recording and analyzing of malnutrition related data by all partners involved in malnutrition management, which would in turn support faster and efficient decision making thus leading to better service delivery.

**Overall Objective of the project:** The objective of this project was to find out how a Malnutrition Management Information System can be applied in management of

**malnutrition related activities on a real-time basis, the information system would allow access to a common platform where all actors in the malnutrition management program can update and get information to support decision making.**

Implementation of an ideal Malnutrition Management Information System would **improve the data collection, analysis and sharing process**. A Malnutrition Management Information System would also **incredibly reduce time** taken to collect, analyze and share information which would in turn support better and faster decision making.

A MIS solution would also **provide a faster and better data collection experience for staff working in the field**. The staff would also have an opportunity to conduct individual trend analysis on the population that they are in charge of and hence achieving more efficient malnutrition management. Currently, each social worker uses a manual register to record details for each child in the malnutrition program. Once the child has left the program, the data regarding this child can easily be phased out upon replacement of the register and incase of malnutrition relapse, the health worker has to trace back old records in order to obtain data regarding the affected child. This not only delays the process of service delivery but also eliminates the opportunity to have tangible reference data for the affected population both for past and present scenarios. This in turn makes it impossible to predict future malnutrition trends.

## **1.2 Objective of the project.**

- This project focused on finding out how current malnutrition management techniques could be enhanced to enable use of real-time data in management of malnutrition related activities (data collection, data analysis and decision support).
- A prototype was developed to demonstrate how Management Information Systems could be applied in management of malnutrition activities in specific populations on real-time basis.
- The prototype was tested to find out whether it can be effectively applied in supporting decision making in malnutrition management programs.

### **1.3 Research Questions**

What challenges are currently experienced in the malnutrition management lifecycle?

Would use of real-time data in managing malnutrition be effective in resolving these challenges?

### **1.4 Scope**

The research entailed an assessment of the current manner in which malnutrition related activities are managed and evaluation of how data sharing and decision making is supported using the shared data. An assessment was done on how MIS solutions would be applied to assist in various stages of malnutrition management to enhance decision making. The research also focused on development of a mobile and web based application to demonstrate how the platform system would be used to support data collection and data sharing which would enhance faster decision making.

## **CHAPTER TWO**

### **2. LITERATURE REVIEW**

#### **2.1 Introduction**

Literature review of various tools and methods used in malnutrition management was conducted. The aim of the review was to understand how malnutrition management programs are currently implemented. This section gives a detailed discussion of the literature review process and goes further to explain the limitations surrounding various methods that are currently used in malnutrition management in refugee situations.

#### **2.2 Standardized Expanded Nutrition Survey (SENS) guidelines. (SENS guidelines).**

According to the UN Refugee Agency, SENS is a tool that was developed by the UN Refugee Agency in consultation with expert organizations and individuals in the fields of nutrition, public health, food security, water sanitation and hygiene, and malaria prevention to develop guidelines for the crucial collection of nutritional and health information from these populations on a yearly basis .

The UNHCR SENS guideline are aimed at supporting UNHCR health and nutrition coordinators and partners to standardize the way annual nutrition surveys are conducted. A 2009 review of UNHCR nutrition surveys worldwide highlighted a lack of standardization in data collection methods, the type of information collected, and in the ways it was analyzed and presented. In order to measure trends over time surveys need to be replicable and the same definitions, geographic boundaries, and methodologies need to be used from year to year.

SENS is conducted in six steps. **Planning step:** In this step, relevant information is gathered about the population to be surveyed. This information is then used to decide which population is to be surveyed. Resources for conducting the survey and the questioner for the survey are then identified to suit the local setting where the survey is to be conducted. **Training step:** Survey teams are trained to collect data, take the measurements, conduct interviews, record observations

and select the households following predefined survey protocols. **Data collection:** During data collection, surveyors work in teams of 4-5 people. The teams are supported by the survey coordinator and survey supervisors who also verify the quality of collected data on a daily basis. **Data Entry:** If data has not been collected using mobile phones, it must be entered into the recommended computer software. Data entry: should preferably be done in parallel with data collection, rather than at the end of all fieldwork. **Data verification and analysis:** Data is cleaned and analyzed using ENA for SMART and Epi Info software. **Reporting and representing:** After the data has been thoroughly collected, verified and analyzed, the survey coordinator writes the report. The report contains the survey's comprehensive results and recommendations, and is communicated to the relevant, appropriate people for action on those recommendations. **Some of the reports produced after this process related to Levels of malnutrition and key health indicators in children.**

#### **Use of mobile technology in data collection using SENS guidelines:**

Android mobile technology has been used to improve data collection in survey. The aim is to improve the quality of data and to reduce time spent in recording data. Use of mobile technology has been seen to also assist in refining the process of data collection because the software used during data collection is custom designed to focus on particular aspects of the sample population. In this technology allow staff to follow predefined questioners.

Application of SENS in nutrition survey has been seen to improve the quality of data especially because of its ability to use mobile phone technology in data collection, other advantage of this method include, reduction of time spent in data processing because this method has eliminated by data entry done at the time of taking readings. The method has also motivated staff involved in the survey because with proper training, staff members are able to collect data effectively while at the same time there is no need to later repeat the data entry process. The method is only applied in surveys thus does not address the real need for malnutrition management once the nutrition survey is completed. The SENS method only produces information on nutrition levels in children which does not assist in managing the process of managing the malnutrition in

children who have been identified to be malnourished during the survey. The SENS method does not also support the ability to perform data analysis on data that is collected during the survey. The methodology uses multi layered approaches where data obtained in the survey is first added to excel and clean and later analyzed using the SPSS or other data analysis tools. This in turn delays the process of data analysis. The SENS method hence does offer real time support in decision making for malnutrition management.

### **2.3 Malnutrition management using registers and data analysis tools.**

An assessment of various tools that are used to measure malnutrition revealed that routine management of malnutrition activities is achieved using manual registers and data analysis tools.

There are several manual registers to support data collection at different levels of malnutrition management. For routine management of each child records containing details of each child is maintained in the manual register. The register has provision for 12 reading which corresponds to the number of time the child should be monitored if their situation has not normalized. Every week the health worker in charge of a given population goes around the camps taking readings of the affected children and records the findings in the register. Information obtained is then availed to relevant persons to support decision making and to assist in data analysis.

Every week all the data obtained after the routine visits is analyzed using MS Excel or SPSS and distributed amongst all organizations responsible for managing refugee affairs. The information is also added to health information system at country level to support decision making.

The main challenge experienced when using registered the need for staff member to repeat the process of data entry by transferring data from the manual registers to MS Excel or SPSS. This delays the process of data analysis. This process is particularly a challenge in emergency situation where immediate decision making is required. The process also involves a lot of data cleaning that can delay the process of data analysis. This project will focus on establishing how data collection, data analysis, data sharing and decision making can be achieved without applying a multilayered approach and more importantly eliminating the use of delayed data an

instead apply real-time data, this will not only reduce the time taken to make decision but also help in detecting emergency malnutrition situation and at the same time assess the magnitude of malnutrition at a given time.

## **2.4 Health Information Systems**

Health information systems are designed to support decision making by using reports upon analysis of data in the population covered by a given organization. In the case of a refugee situation, the Health Information System gets it's data from the reports provided weekly or monthly after data analysis. Most of these systems cover a wide range of health issues in the broader scope of public health, malnutrition is one of the aspects availed in such system. These systems are also designed to alert the persons concern in case the data populated in them shows levels of concern, example when there is a disease outbreak. The data contained in these systems represents monthly or weekly summary reports regarding health situations in the refugee camps.

HIS do not support data analysis but are rather designed to hold information obtained after data analysis. In the case of malnutrition management, these systems cannot support the day to day management of malnutrition, they neither represent the atomic aspects that need to be managed during the process nor do they support analysis of data that is obtained after recording of malnutrition reading. These systems only come in handy when sharing information which has been obtained during data analysis. Due to the ability of HIS to support other aspects of health and nutrition, they are a good tool for recording malnutrition data, they however need to be complemented by tools that can provide more timely and accurate information. In this case such systems could be linked to real-time malnutrition management systems in order to enhance timely and accurate information which can in turn support decision making.

## **2.5 Global refugee database system**

All refugees and persons of concern recognized by the global refugee agency are registered on a database system to enhance service provision to refugees and support data sharing among the partner agencies that deal with refugee affairs. Some of the services provided to refugees include

shelter, food and education. The global refugee agency coordinates with specialized agencies to support the provision of nutrition services, the partners depend on information provided by the global refugee agency when accessing and dealing with refugees. There for the main data source for which supports refugee services is the registration system owned by the global refugee agency.

This database system incorporates information regarding all persons who are recognized by the global refugee agency, that includes refugees and asylum seekers and stateless persons. The information is designed to allow all persons who present themselves to this organization to be registered together with their family members. In that case all refugees belong to a household depicting a family composition. The family is also given a number which they use to access services from all organizations responsible for refugees.

Since only the global refugee agency has access to this database system, each house hold of refugees is normally given a card which has a number and which is presented to other organization when the refugees need to access services, this includes when getting food rations from the partner agency in-charge of food distribution.

This project will not focus on registration of refugees because this work has already been extensively done and is proven to be working. The project will however determine how malnourished children can be registered using the reference details already in use by the main refugee agency. This reference details will also provide a basis for defining how information regarding the malnourished child.

## **2.6 GINA: Global database on the Implementation of Nutrition Action (GINA)**

The **Global database on the Implementation of Nutrition Action (GINA)** is an interactive platform which was developed by the World Health Organization for sharing standardized information on nutrition policies and action. Some of the policy data contained in GINA include Meta data which users can apply when referencing country related information. Information

regarding partners involved in malnutrition related activities and policy and legislation extracts to support implementation of malnutrition programs.

Country	Action/Policy title	Type *	Start date	End date
Afghanistan	United Nations Development Assistance Framework, In support of the Afghanistan National Development Strategy	P	01/2010	01/2013
Albania	Law nr Nr 8528, date 23.9.1999 for breastfeeding promotion and protection	P	01/1999	---
Albania	'Prevention of iodine deficiency disorders using Universal Iodization of salt Programme			
Angola	United Nations Development Assistance Framework in Angola	P	01/2009	01/2013
Antigua and Barbuda	Infant and Young Child Feeding Policy	P	---	---
Argentina	Resolución Conjunta 97/2007 - 301/2007 Secretaría de Políticas Regulación y Relaciones Sanitaria - Secretaría de Agricultura, Ganadería Pesca y Alimentación.	P	---	---
Armenia	United Nations Development Assistance Framework 2010-2015 in Armenia	P	01/2010	01/2015
Armenia	The program of flour fortification in Armenia - All population groups	A	---	---
Armenia	Advertising Act	P	---	---
Austria	Nationaler Aktionsplan Ernährung [National Nutrition Action Plan]	P	01/2010	01/2020
Austria	Programme of the Austrian Federal Government for the 24th Legislative Period	P	01/2008	01/2013
Austria	Arbeitsprogramm [Work program]			
Austria	Public health in Austria			
Austria	Austrian strategy for sustainable development.			
Austria	Säuglingsanfangsnahrung und Folgenahrung [Ordinance on Infant formula and follow-on formula]	P	---	---
Azerbaijan	United Nations Development Assistance Framework 2011-2015 Azerbaijan	P	01/2011	01/2015
Bahrain	Obesity & Chronic diseases			---
Bahrain	Malnutrition			

\*Type: A = Action; P = Policy

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Hyperlink from title opens summary factsheet for each policy and action

Export results table

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Global database on the implementation of Nutrition Action (GINA)

**Figure 1: A screen shot of the GINA system**

**Source of the figure: The World health Organization website. From year 2012**

## **2.7 Nutrition Landscape Information System (NLIS):**

It brings together all existing WHO Global Nutrition Databases dynamically, as well as other existing food and nutrition-related data from partner agencies, NLIS is a web-based tool which provides nutrition and nutrition related data in the form of automated country profiles and user-defined downloadable data. This system offers already analyzed data which support decision making. This system offers a platform that can provide information for decision making but does provide information that can support the management of malnutrition activities on real time basis. This is an example of systems that obtains information from real-time management and assessment of malnutrition activities; it does not offer the actual solution to manage the activities going around during malnutrition management.

## **2.8 Management Information System**

Management information system, or MIS, broadly refers to a computer-based system that provides managers with the tools to organize evaluate and efficiently manage departments within an organization. In order to provide past, present and prediction information, a management information system can include software that helps in decision making, data resources such as databases, the hardware resources of a system, decision support systems, people management and project management applications, and any computerized processes that enable the department to run efficiently.

## **2.9 Limitations of current methods in providing decision support for malnutrition management programs**

Based on initial assessment of malnutrition activities and after conducting literature view it was noted that some of the short comings faced in malnutrition programs include:

- Time inefficiency during data collection and analysis. It takes at a minimum one month to design and execute malnutrition actives and in this case not including the process of managing malnutrition. In order to obtain the data, surveys are conducted on sample population, the data obtained from surveys is the used to implement malnutrition program.
- Use of multilayered processes to collect and analyze data also introduces disintegrated layers of data available both in manual and electronic systems. This creates a lot of challenges for decision makers who have to depend on multiple data sources to make conclusive decisions.
- Data sharing among different organizations that are involved in managing malnutrition programs is also limited by this multilayered approach. There are high possibilities for data inconsistencies, which could lead into conflict in decision making and could jeopardize service delivery.

- Replication in data processing activities: In the current set up most of the data processing activities require both manual and electronic data recording. This creates a lot of repetition in data collection activities. All the organization involved in managing malnutrition at some point also have to perform individual data analysis. Data processing in such an environment not only eliminates efficient delivery of service, but it also reduces staff morale.

## **2.10 How the prototype will address issues identified in current systems.**

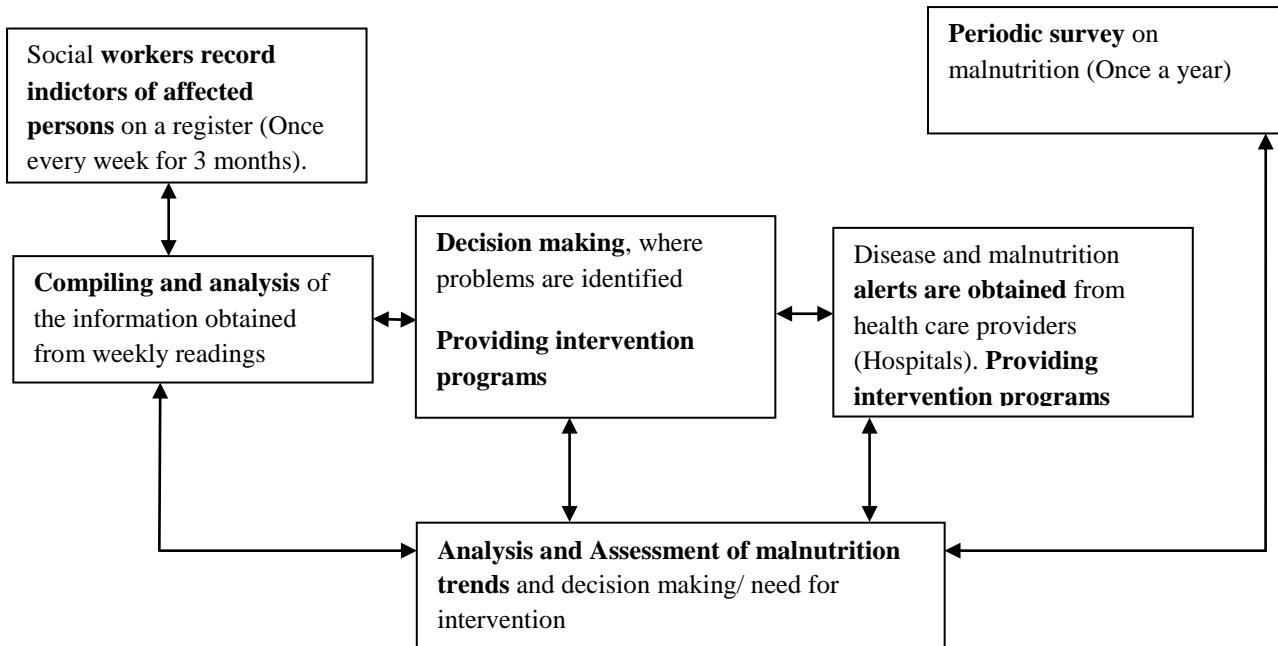
- The prototype will demonstrate how an integrated approach of data collection and analysis would be applied in managing malnutrition in refugee children.
- The prototype would also provide a more refined way to perform data analysis and at the same time provide trend analysis needs for all stakeholders involved in malnutrition management.
- The prototype will also eliminate the need to manually collect data during the malnutrition management process.

## **2.11 Application of a real-time Management Information System in supporting Malnutrition functions**

The model below shows how different functions interact during malnutrition management. The model demonstrates the level of information dependency amongst actors in the malnutrition program regardless of minimal interaction that currently exists amongst the variously function. In this regard, a real-time management information system would ensure that staff members assigned to different functions can access real-time data when performing their duties while at the same time not have to keep sending requests to their team in different function. Geographical location is also a hindrance in the current processes because of the disperse placements of the persons of concerns (refugees) and the fact that sometimes staff managing some programs are

located in country level, regional level and global level thus are not always at the place where activities are taking place to support decision making.

The research focuses on finding out how a real-time application would be used to collect, analyze and provide information to support decision making. The research prototype that was developed is composed of two components. A mobile application which would assist in routine monitoring of malnutrition activities in affected population, the mobile app was designed to enable users to collect data from the affected population and record it on the mobile application. The web app would enable users located in offices across a larger geographical location to view and add more information as per the need of their specific functions and to support decision making. The next chapters of this report takes an in-depth discussion on how research, development and testing of the mobile and web application was conducted.



**Figure 2: Conceptual model, representing the current malnutrition management program.**

**The above figure demonstrates how multilayered repetitive activities cause duplication of effort when managing malnutrition related functions in refugee camps.**

## **CHAPTER THREE**

### **3. RESEARCH METHODOLOGY**

#### **3.1 Introduction**

This chapter explains in details the research methodology used in the study, instruments for data and analysis are also defined.

#### **3.2 Research approach and design**

A quantitative approach was followed in conducting the research. A quantitative research is define as a formal, objective and systematic process to describe, test relationships and examine causes and effects. ( Burns and Grove (1993:777)). An experimental survey design was used. Experimental designs are developed to answer hypotheses, or testable Statements, formulated by researchers to address specific questions. An experimental design approach was found suitable for this project because it would provide a systematic structure for analyzing questions the research question. The ability of this method to support assessment of specific aspect of the research questions was important in evaluating the needs of all elements that form the malnutrition management process and linkages that exist within this process thereby providing key indicators that were used in formulating a real-time malnutrition management information system solution which has been discussed in this project.

**Research setting:** This research derived knowledge from malnutrition management activities in refugee populations within Kenya. The sample population whose data was assess is composed of children refugees aged between 0-65 months old. The research knowledge was obtained by analyzing the malnutrition management processes, data and relationships that exist in malnutrition management.

**Source of research information and feedback:** Health and social service officers working in refugee programs were the main respondents to this research. In order to expand the knowledge

obtained from these sources, a further review of pre-existing malnutrition management literature was done. Some of the information reviewed includes tools, process and guidelines that are currently used in malnutrition management.

The background of this research was to emphasize the use of informatics/computing solutions in managing information for faster and efficient service delivery (focusing on health sector). Throughout the research, reference of on informatics/ computing knowledge and guidelines was made in order to come up with a suitable solution to malnutrition management. This solution has been demonstrated in this prototype.

**Maintaining validity and reliability of the instruments:** To ensure accuracy in the quality of the research study, measures were put in place to control the data collection methods, some include control of the interview process, interview questioners were well defined to ensure that the questions listed were reflective of the objective of the study. During the data collection activities, reference was made to the objective of the project to ensure that the findings obtained did not divert from the research objective.

### **3.3 Data collection**

Data collection, according to Burns and Grove (1999:43), is the accurate and systematic gathering of information relevant to the specific objectives and questions of a study. The study variables are measured using a variety of techniques such as observation, interviews or questionnaires. Research data in quantitative studies are often collected according to a structured plan, using self-administered questionnaires with questions that have pre-designated response options. Research questions were formulated to facilitate effective collection of information that was required in this research. Both open ended and closed questions were developed. To ensure control in the process interviews formed the main basis for data collection.

**Interviews:** In order to obtain an in-depth understanding of malnutrition processes, a health and a social specialist working with refugee were interviewed. The focus of the interview was to understand the following:

- How malnutrition is measured and how tools for measuring malnutrition are applied in the refugee camps?
- What information is required at every stage of malnutrition management?
- What aspects currently cause delays in delivery and processing of information?
- What are the roles involved in malnutrition management and what are their responsibilities?
- What is the shortcoming experienced in current malnutrition management processes?

**Evaluation of existing malnutrition management tools:-**This involved an assessment of available malnutrition management tools: Various templates and reports that are used during the malnutrition management process were analyzed to understand the reporting requirements. Malnutrition data collection templates were also assessed to understand what kind of data is collected during routine monitoring and how this data is translated to various reports. Some of the tools that were assessed during this stage include;

- Malnutrition monitoring registered which are used to record malnutrition reading.
- Malnutrition reports which contain summary information regarding malnutrition activities in target populations
- Nutrition survey tools which are used to conduct periodic malnutrition survey among the affected entire populations of refugees.

**Literature review:** This involved analysis of work previously done to support malnutrition management for specific population and assessment of various products that are currently available for supporting malnutrition activities. The studies also defined what has not been done in current work and how it would be achieved in this project.

### **3.4 Data analysis**

The aim of data analysis was to identify themes relating to malnutrition and extract useful ideas which would support the design process of the proposed MIS prototype. (Miles Huberman

(1994:10) defined data analysis as consisting of three concurrent flows of activity, namely data reduction, data display and conclusion drawing.

Data reduction is selecting, simplifying and transforming data that appears in its original format. In order to obtain all the relevant data regarding the malnutrition management process, these activities were performed:

**Classification of data:** All the data collected from the data collection activity was first classified based on the process within which the data is executed. The aim of data classification was to ensure that further correlation between processes could be done. This would facilitate data flow during the analysis and design stage. This process was also instrumental in defining a suitable data structure for the malnutrition management system.

**Definition of inter-dependency within data:** Once the data was classified, relationship within data elements was defined. This process was very useful because it is within it that a clear process flow was established.

**Eliminating unnecessary data elements:** The final stage was to eliminate duplicate entities in the data, the resultant elements displayed refined information that could be used as the foundation for designing a real-time malnutrition management system.

Data display involves presentation of the outcome of the data reduction process, while focusing on answering the subject in question (in this case the focus was the malnutrition management process). The data display process also acts as a systematic guide to implementing the solution to a given question.

The outcome of the data obtained during the data reduction process was displayed using various formats like flow charts, the aim of this charts was to show how information flows in the malnutrition management process. The data was also displayed in tables to show classification amongst data. The resultants elements were referenced during the design process and formed the bases for defining the system.

### **3.5 Testing the prototype:**

Various testing procedures were conducted in order to qualify the Management Information System's ability to support malnutrition management activities. The test procedure was conducted for refugees living in Nairobi.

#### **The test procedure was conducted to assess the following aspects:**

- A test to assess whether the prototype has met system requirements as identified in the initial study of the research: Key requirements include whether the prototype could provide a centralized spot for malnutrition management which would enable real-time access and update of malnutrition data
- Assess whether the system can provide a user friendly interface to all system users both during data input and output. The aim of this testing was to assess the level of satisfaction amongst system users during data collection and ability for users to assess information as per their job requires.
- Easy of setting up the system: The aim of this test was to assess how easy it would be to rollout the system in a real environment. The test also focused on assessing how easy it would be for users to learn and use the system.

#### **The test was carried out amongst the following users:**

- Three Social Health workers in Nairobi: The social workers are in charge of monitoring the malnutrition levels a given population. The social health workers also identify needs for malnutrition treatment.
- Two Clinical officers in Nairobi: These are the medics and are in charge of providing health care service and identifying need for malnutrition treatments.
- One staff operation officer in charge of coordinating nutrition activities.

**Test design:**

- The test was designed to take place amongst 6 selected users working in malnutrition management programs for refugees within Nairobi.
- The test was to run for two weeks based on the ability of the user to give feedback, where not possible the users would request for extension.
- Each user was to follow a questionnaire which acted as a guide on what to test in the system, this was to ensure that the required test results could be obtained from the feedback received from these users.
- A questionnaire was designed to help the user give the necessary feedback upon using the system. The questionnaire is attached at the end of this report.

## **CHAPTER FOUR**

### **4. SYSTEM DEVELOPMENT**

#### **4.1 System Analysis**

This section defines how system analysis was conducted to come up with requirements of the Malnutrition Management Information System.

##### **4.1.0 Defining the requirements of the malnutrition Management Information System**

###### **A. Need for a tools that can allow effective and timely data collection:**

Based on the information provided in the previous chapters, some of the challenges experienced during data collection in malnutrition management program include; error in the data, lengthy and time consuming data collection processes, loss of data and reduces motivation amongst the staff members who are in charge of data collection.

**To achieve efficiency, the data collection component in the prototype was designed to include features that would support:**

- Ability to verify the data upon entry during data collection.
- Ability to reference previous reading regarding the affected population.
- Faster and easy to use interfaces for data collection.
- Ability to easily compute malnutrition information and show simple results that would be used to make first level decision regarding a child's malnutrition status.

**Data is collected at two points in the malnutrition management process, which include:**

- **During malnutrition monitoring visits:** Based on information obtained during the research it was found that all children in the program are first enrolled in the program by

registration. Details regarding the child and their house hold are collected at the registration phase. This information includes the following:

- **Bio information of the affected child:** Name, Date of Birth, Country of Origin, location of the child and family reference codes.
- **Malnutrition reading:** Once a child has been enrolled on the program, their malnutrition data is recorded on weekly basis. This information forms the basis for malnutrition management and is regularly analyzed to support malnutrition programs. This information includes: **Weight, Height and Middle Upper Arm Circumference**
- **During clinical visits:** Malnutrition management programs are dependent on health history of affected population, therefore the need to integrate clinical information in the malnutrition programs. Upon visit at the clinic, the health service provider is able to issue alerts whenever they encounter children whose malnutrition conditions need to be monitored. Some of the information collected during clinical visits and which is availed to the malnutrition programs include the following;
  - **Malnutrition readings** for the child, this includes readings for children who have not been enrolled in the programs. The data is relevant in assessing whether the child should be enrolled into a malnutrition program. The data includes **Weight, Height and Middle Upper Arm Circumference**. The data is share with the malnutrition team to enable follow up in case there is need for intervention.
  - **Clinical details in case of malnutrition related ailments:** If the clinical officer encounters a child with illness that is related or associated with malnutrition then there is need to issue share this information with the malnutrition management team.

## **B. Functions to allow fast and effective data manipulation.**

Accurate data forms a key part of decision support in malnutrition programs, but the data is only as useful as its analysis. An assessment of the current malnutrition processes indicated that upon data collection during field work, data is first populated in SPSS or MS Excel after which analysis is performed based on the needs of the decision maker. Key elements that would need to be included in such a system are:

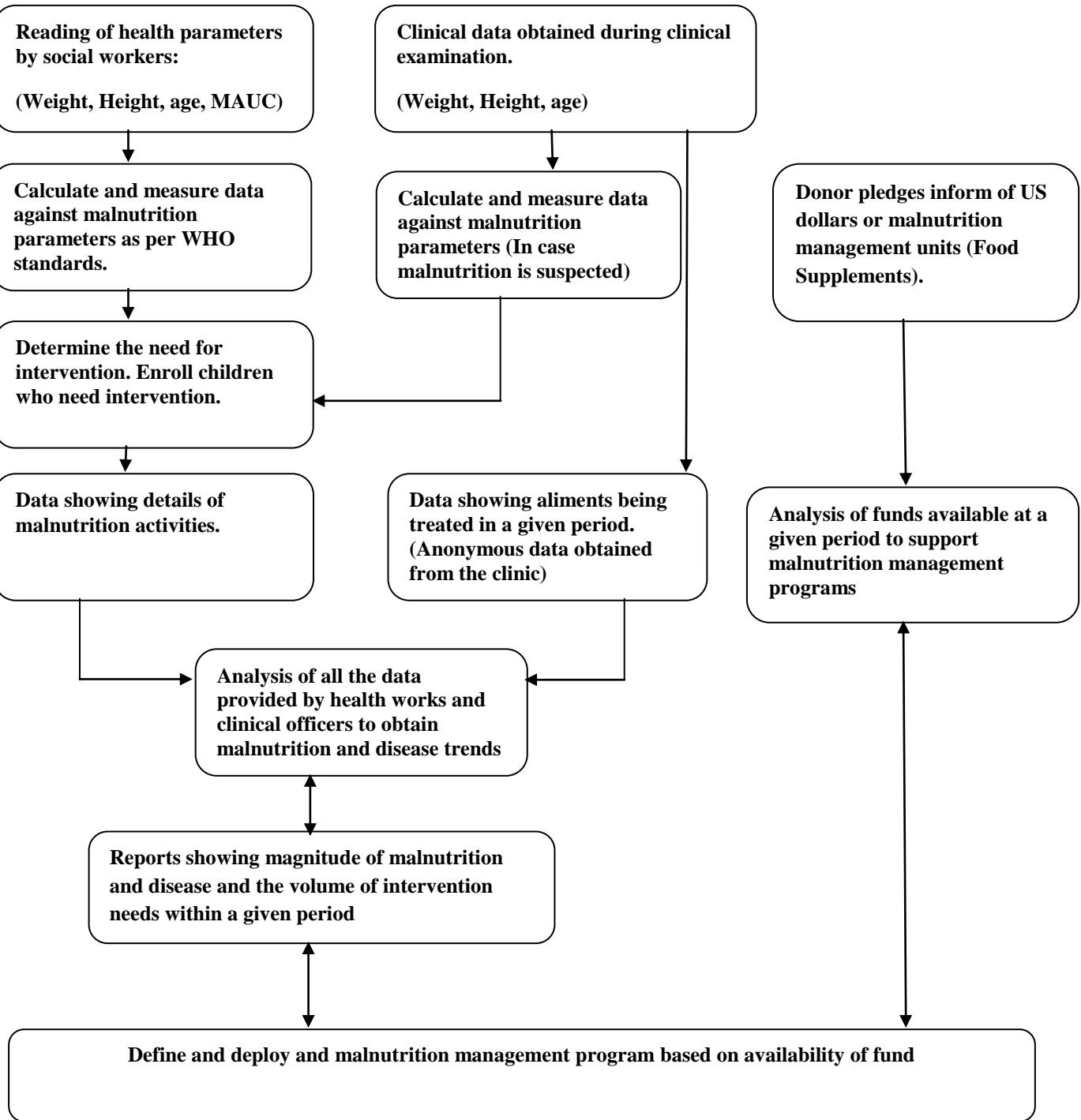
- During routine malnutrition reading, health workers need access to malnutrition parameters to formulate malnutrition indicators for each child. It was found useful to incorporate these functions in the Malnutrition Management Information System ensure effective calculation of malnutrition indicators.
- The health workers and social workers need to exchange information regarding children under their observation. To ensure real time update and access of data, there system would need to have a platform where both users can share input by issuing and acting on malnutrition related alerts.

## **C. Platform to allow decision makers to access live information regarding ongoing malnutrition information.**

The motivation behind developing a prototype for malnutrition management system was to enhance decision making by providing a platform where all decision makers/partners involved in decision making would access malnutrition related information on real-time basis. The prototype that was developed comprises of a platform that decision makers can use to view malnutrition trends in specific locations. The prototype was developed to provide a platform that would allow management to allocate resources based on malnutrition needs of the population as indicated by the malnutrition trends.

## **D. Security feature to ensure that the system is tamper proof.** Due to the sensitivity of the malnutrition data, it was deemed important for the malnutrition management information system to have components that would prevent unauthorized users from

accessing information in the system. User authentication was used as the key feature to ensure that only eligible users can access information on all the platforms of the prototype.



*Figure 3: process model of malnutrition activities in malnutrition management programs. Demonstrates how data is exchanged between various functions in malnutrition management programs.*

## **4.2 System Design.**

### **Introduction**

The design phase focused on creating a prototype that would support implementation of solutions to the requirements that were defined in the analysis phase. The overall requirement was to create a prototype that would support real time information system that would support malnutrition management activities..

As discussed in previous sections. The malnutrition management process in refugee environment is achieved through service delivery by multiple organizations which specialize in various functions, some of which include; health service, social services, refugee affairs (protection), host governments services, food distribution, children welfare and livelihood programs.

### **4.2.0 Scope of the prototype**

This research focused on creating an information system covering activities of three of the above mentioned functions. These three functions include:

- **Monitoring of malnutrition amongst children in refugee camps – Service is provided by Social health workers:** - The MIS was designed to include a component to support day to day activities by social/health workers. Some of the activities conducted during monitoring of malnutrition includes:
  - Registration of children affected by malnutrition. The registration information includes, name date of birth, location, parents names.
  - Collecting of malnutrition readings: Data includes: Height, weight and week when the data was collected.
  - Data analysis
  - Deregistration of children treated for malnutrition.

- **Clinical health management in refugee camps- This service is provided in hospitals or clinic by medics:** - To allow early detection of malnutrition amongst the population, monitoring is done during clinical visits. This research focused on demonstrating how medics at the hospital would use the malnutrition management information system to trigger follow up of children, in case the children are found to show signs of malnutrition. The mobile app was also designed to allow social workers access to information once alerts have been issued by medics during clinical visits. Some of the roles of the medic in the malnutrition process include:
  - Sending alerts
  - Issuing instructions to help malnutrition management in refugee camps
- **Portal to support decision makers:-** Decision making in malnutrition programs are mainly lead organizations that are in charge of entire refugee activities this agencies depend on the above two specialist functions/ agencies to make decision. Information availed to this functions is used when planning and/or fund raising for malnutrition programs. The reporting platform was designed to support trend analysis and reporting on malnutrition using live data being collected during day to day management of malnutrition activities.

#### **4.2.1 Design of the system components**

This section describes the structure of system and subsystems that make up the malnutrition management Information Systems. The architecture of this prototype was designed bearing in mind the environmental and operation setting of refugee camps. Some of the factors include:

- Hostile work environments in the camps, social workers have to walk for long to provide services to refugees. It would not be ideal for them to carry heavy equipments to these locations like laptops and manual registers like in the past. In this case mobile platforms provide ideal solutions for day to day monitoring of malnutrition activities. Mobile technology is available in most camps either through local service providers or satellite

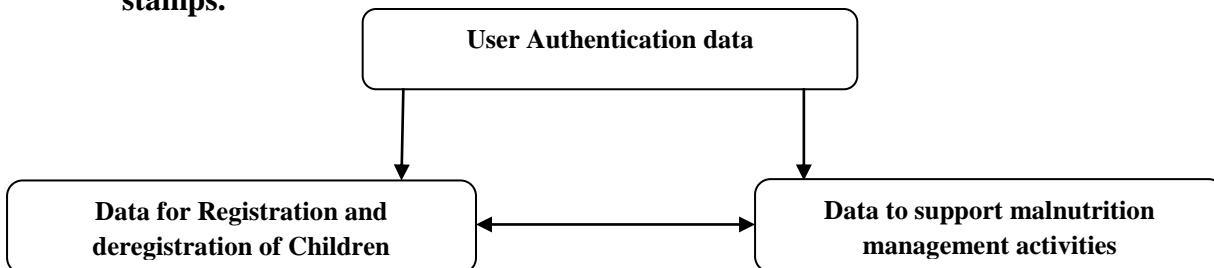
services provided by agencies managing refugee activities. This therefore supports the use of mobile applications in refugee camps.

- As discussed earlier the diversity in service provision creates a need to have a web platform where various functions/agencies can upload and access data regarding malnutrition. Since management activities are carried out in offices close to the camp or within clinics and hospitals, it is possible for them to use web applications either on their phones or computers to access malnutrition information. A web platform has been found to be most effective to support decision makers/management and clinical officers involved in malnutrition management.

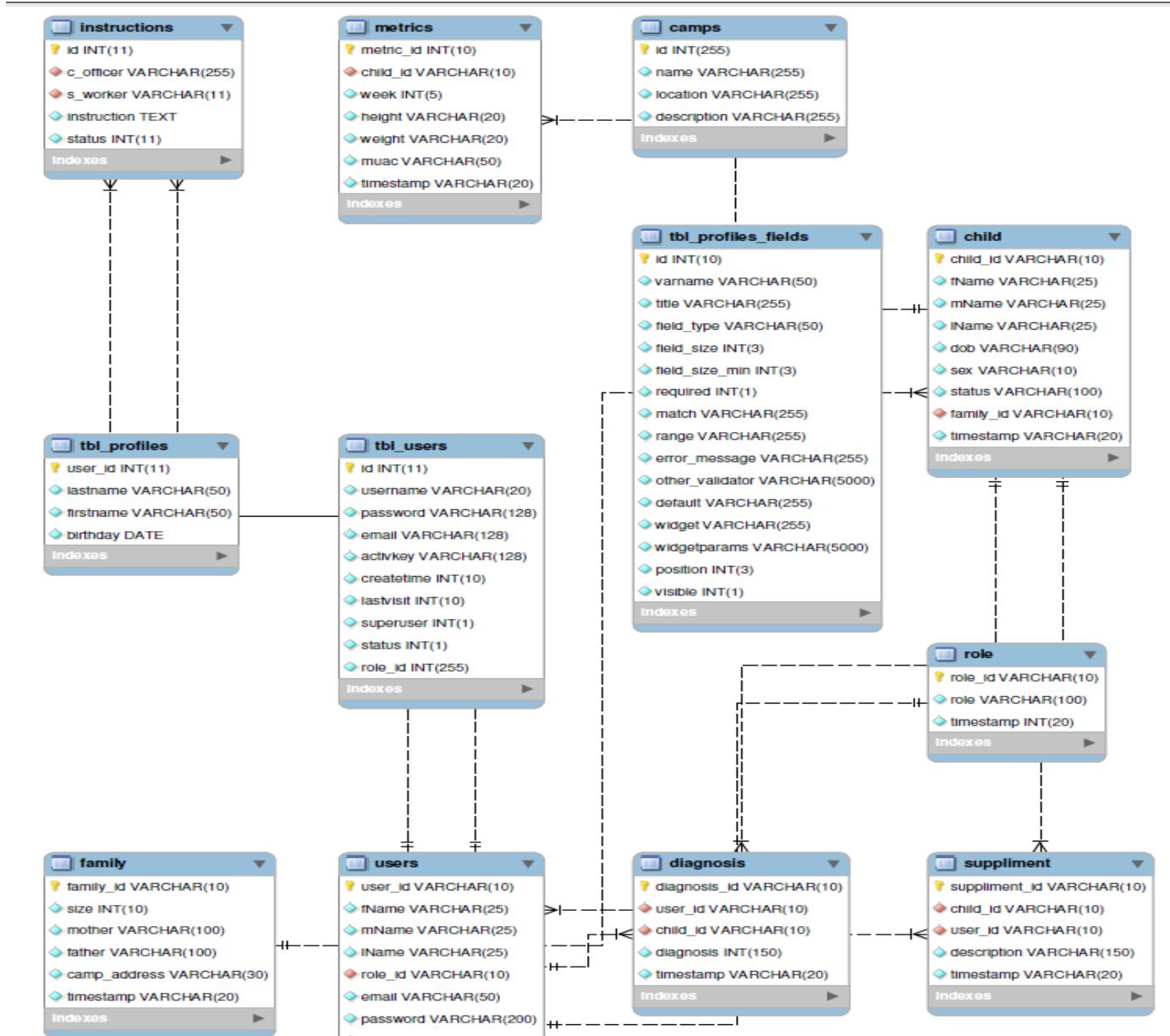
Data elements in the Malnutrition MIS were organized in to entities comprising of the following components

- **Data elements to support registration and deregistration** of children in the MIS: elements in this component include:
  - **Bio data elements of the child being registered in the program: name, age and gender.** This information would be useful during routine monitoring of children who are under the malnutrition program. Social workers would depend on this information to assess their progress and to identify the child during the visits
  - **Data elements relating to the families with children affected by malnutrition:** This entity is a secondary component of the element above. It would be used to provide more information to social workers on the family composition and social status of the family of the affected children. The family ID for each family would also serve as the link between the family and children in each Household that are registered in the malnutrition program.

- **Data elements to support capture location details of affected population:** The refugee population is spread across several camps in a large geographical area, location indicators were added to the system to enable social workers to pin/mark locations of affected children.
- **Data elements to support capture of malnutrition matrixes and recording of malnutrition activities**
  - Anthropological Indexes: These are indexes used to measure malnutrition: **Weight, Height, MUAC (Mid-Upper Arm Circumference MUAC).** Gender and age are also malnutrition indexes which are classified in the bio data category of the data structure since they form the basis for defining a child identity which is important during routine monitoring.
  - **Elements to support capture of data regarding routine malnutrition activities.** These data elements are organized to hold follow-up information. These details include information regarding diagnosis of ailments in children, details of supplements to be administered to affected children, information regarding monitoring instructions and alerts where follow up is required.
- **Security and user authentication:** These data elements were designed to allow the systems to capture and hold security information of all staff and management using the system. **These details include, name, job title, organization, user rights and time stamps.**



*Figure 4: Overview of the data structure*



*Figure 5: Detailed representation of the data structure. This is a screen shot of the data structure that was created for the application: Both the web and mobile application.*

#### 4.2.2 Application structure

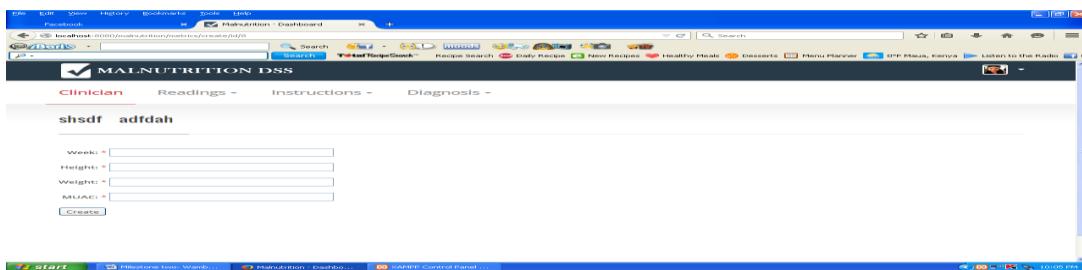
In the analysis phase, several issues were identified relating to challenges experienced in the current malnutrition management process. The most critical of these issues include;

- **Time inefficiency in data processing:** The data collection and analysis process takes several weeks or months to be accomplished. Data is first collected using manual registers and later updated on data analysis tools in order to facilitate data analysis. Due to delay in data processing, the management team will mostly not have accurate information during decision making. Due to the dynamic nature of refugee programs especially during emergencies it is critical to have in place a decision support structure which would ensure that management is aware of what is happening at every point in time in order to facilitate decision making.
- **Disintegration of malnutrition data:** Due to the fact that refugee populations are sparsely populated, most organizations dealing with refugees have disintegrated teams working in various locations to enhance service delivery on ground. This has introduced data structure challenges which cause delays during data collection and analysis.

### **The web based application**

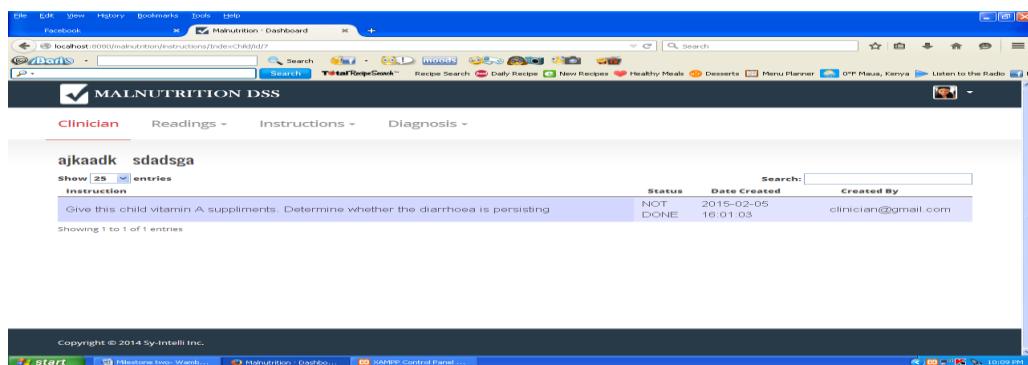
The prototype has been designed to include a web based application which would allow clinical officers and decision makers to access malnutrition related functions. These functions would allow the users to add information regarding the affected children in the malnutrition program. The system would also allow the users especially management to access summary information regarding the malnutrition program. Following are functions available on the web based system. Link to the online version of the web base prototype: <http://54.186.161.132/malnutrition>

- **Adding new malnutrition readings** during clinical visits by children: The clinical officer would have a platform to add data regarding malnutrition readings when treating a child during clinical visits. This metrics would include: - **MAUC, weight and height.** The malnutrition monitoring process can extend up to twelve weeks, in severe cases the process can extend to more than this period. This information would also be added on the mobile platform. There would be need to synchronize data in both platforms periodically while using these systems to ensure that there is no overwriting or duplication in the systems.



**Figure 6: Interface to allow entry of malnutrition readings.**

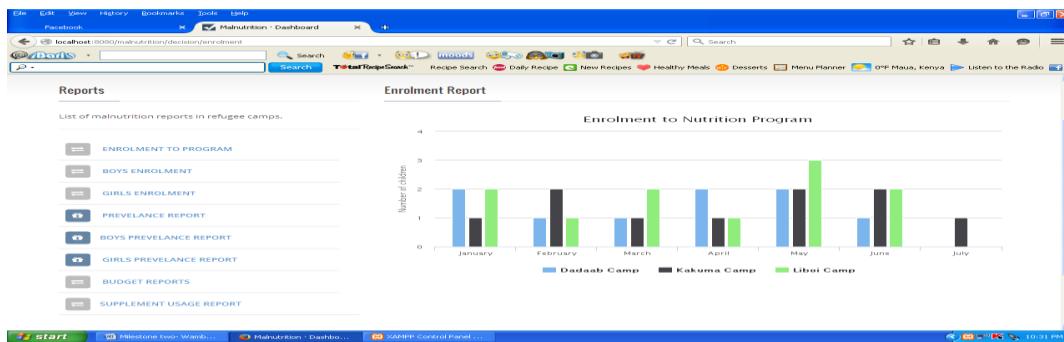
- **Adding malnutrition instruction:** - Upon identification of the malnutrition needs of each child, the clinical officer would indicate on the system what action plan should be taken to correct the malnutrition situation of the affected child. The **web application provides a monitor interface** where new instructions can be added or edited to suit the needs of the affected child. The interface also allows the clinical officer to indicate whether the instruction has been carried out or not. The officer would need to check previous recording regarding the child in order to ensure that there is no contradiction or duplication of ongoing malnutrition therapy information. in the application before deciding on what action should be taken to improve the health of a child.



**Figure 7: Interface showing instructions**

- **Decision support features.** The aim of developing a malnutrition management information system would be to improve decision making and data sharing in malnutrition programs. The decision support component in this prototype provides

dynamic reports that show real-time details obtained from on-going malnutrition management activities in refugee settings. The reports also show trend analysis of activities based on data being added on the MIS. This data is available in form of graphs which can be evolved to provide specific details as per the need of various management in the malnutrition program.



**Figure 8: Sample of reports available of the systems**

- Other reports the decision maker/management would view on the decision support platform include.
  - Enrollment trends based on gender: This would give details regarding the gender of the children in enrolled in the malnutrition program.
  - The system would also provide details of the prevalence rates of different types of malnutrition and malnutrition related ailments. The user would also be able to see the prevalence of malnutrition ailments in girls as compared to boys.
  - The decision maker would also view details regarding budget needs in relation to the program activities. This is very useful function due to the fact that refugee programs are dependent of donor funds

- The reports would also indicate how malnutrition supplements are being managed across the camp.

#### **4.2.3 The mobile application interface**

The figure consists of four screenshots labeled a, b, c, and d, arranged in a 2x2 grid.

- Screenshot a:** Shows the main login screen of the Malnutrition Assistant app. It features a dark blue header with the app logo and name. Below the header, the text "Social Health Worker Assistant" is displayed. In the center, there is a large white button labeled "LOG IN". Below this button, another white button is labeled "CREATE ACCOUNT". The bottom half of the screen is white.
- Screenshot b:** Shows the "Create Account" screen. The top bar says "Create Account". Below it are five input fields: "first name", "middle name", "last name", "id / passport number", and "password". Below the password field is a "repeat password" field. The bottom of the screen is white.
- Screenshot c:** Shows a child profile screen for "John Doe Dorian" (age 34). The top bar shows the child's name and date of birth: "John Doe Dorian" and "dob: 12/10/2015". Below the top bar are five buttons: "Locate Home", "Enter Visit Findings", "Instruction", "View", and "Edit Child Data". The background is white.
- Screenshot d:** Shows a screen for sending instructions. The top bar says "Dorian". Below it, a message is displayed: "Sent by Dr. Joe". Underneath the message are two columns of "Instructions". At the bottom, it says "Sent on 21/10/2015" and "Done on 21/10/2015". There are two radio buttons: "Done" and "Not Done". A "save" button is at the bottom right. The background is white.

**a. The mobile platform will allow social workers to create user accounts and a secure login to children records**

**b. The mobile platform will allow social workers to create user accounts and a secure login to children records.**

**c. Screenshot showing various activities that can be performed on a child in the program.**

**d. Adding instruction.**

**e**

New Child

Apr	09	18 27 28 29 30	1 2 3
May	10	19 4 5 6 7 8 9 10	20 11 12 13 14 15 16 17
Jun	11	21 18 19 20 21 22 23 24	22 25 26 27 28 29 30 31
		23 1 2 3 4 5 6 7	

Female  
 Male

father present  
 mother present

Name of the Camp

**save**

**f**

Dorian

Sent by Dr. Joe

Give the child a vitamin A suppliment. Check whether the diarrhoea has persisted, if it has give the child general supplements

Sent on 21/10/2015

Done on 21/10/2015

Done  
 Not Done

**save**

**e. Screenshot demonstrating how a child is registered into the malnutrition management program.**

**f. Entry of reading during a weekly visit by the social worker.**

**g**

Viewing Dorian

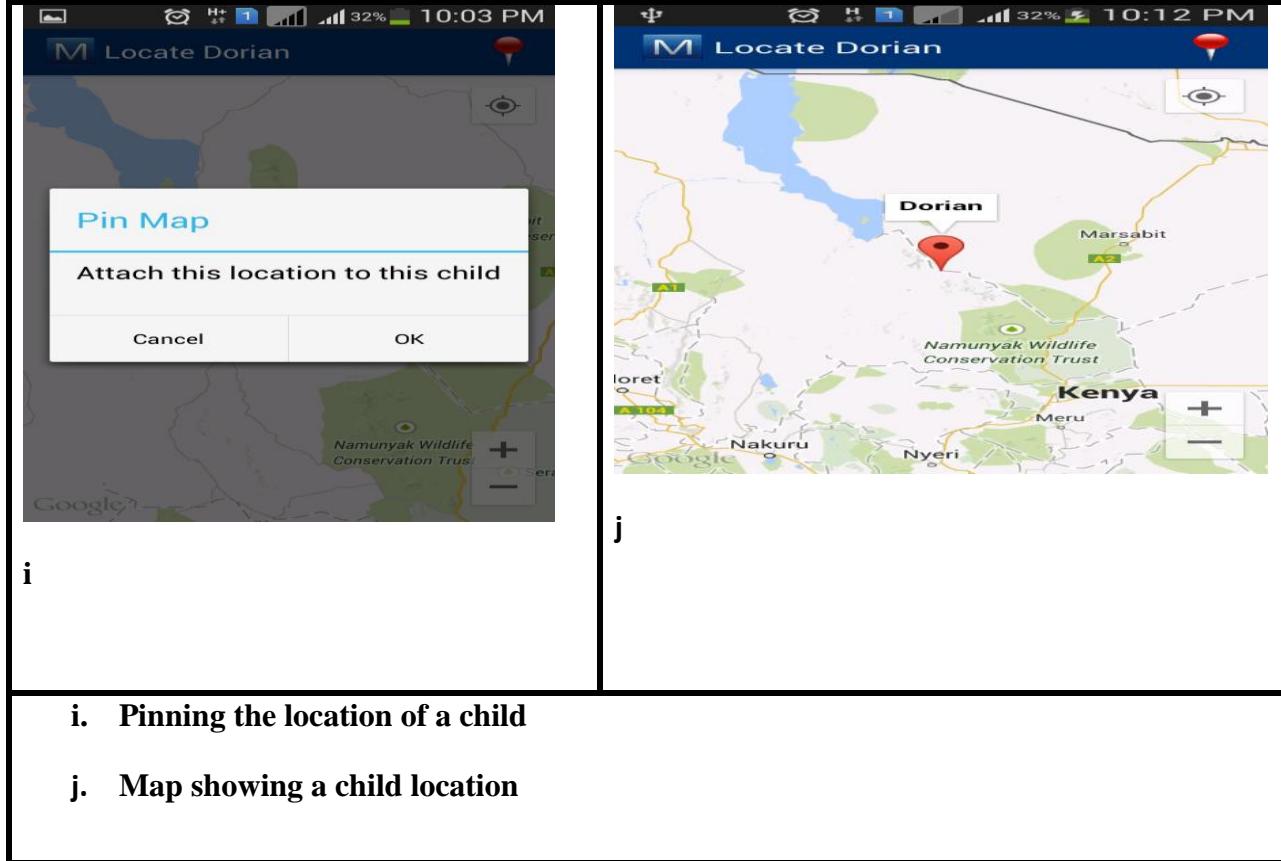
Feb 21 2010	Height 33 Weight 22 MUAC 10
Feb 21 2010	Height 33 Weight 22 MUAC 10
Feb 21 2010	Height 33 Weight 22 MUAC 10
Feb 21 2010	Height 33 Weight 22 MUAC 10
Feb 21 2010	Height 33 Weight 22 MUAC 10
Feb	Height 33 Weight 22

**h**

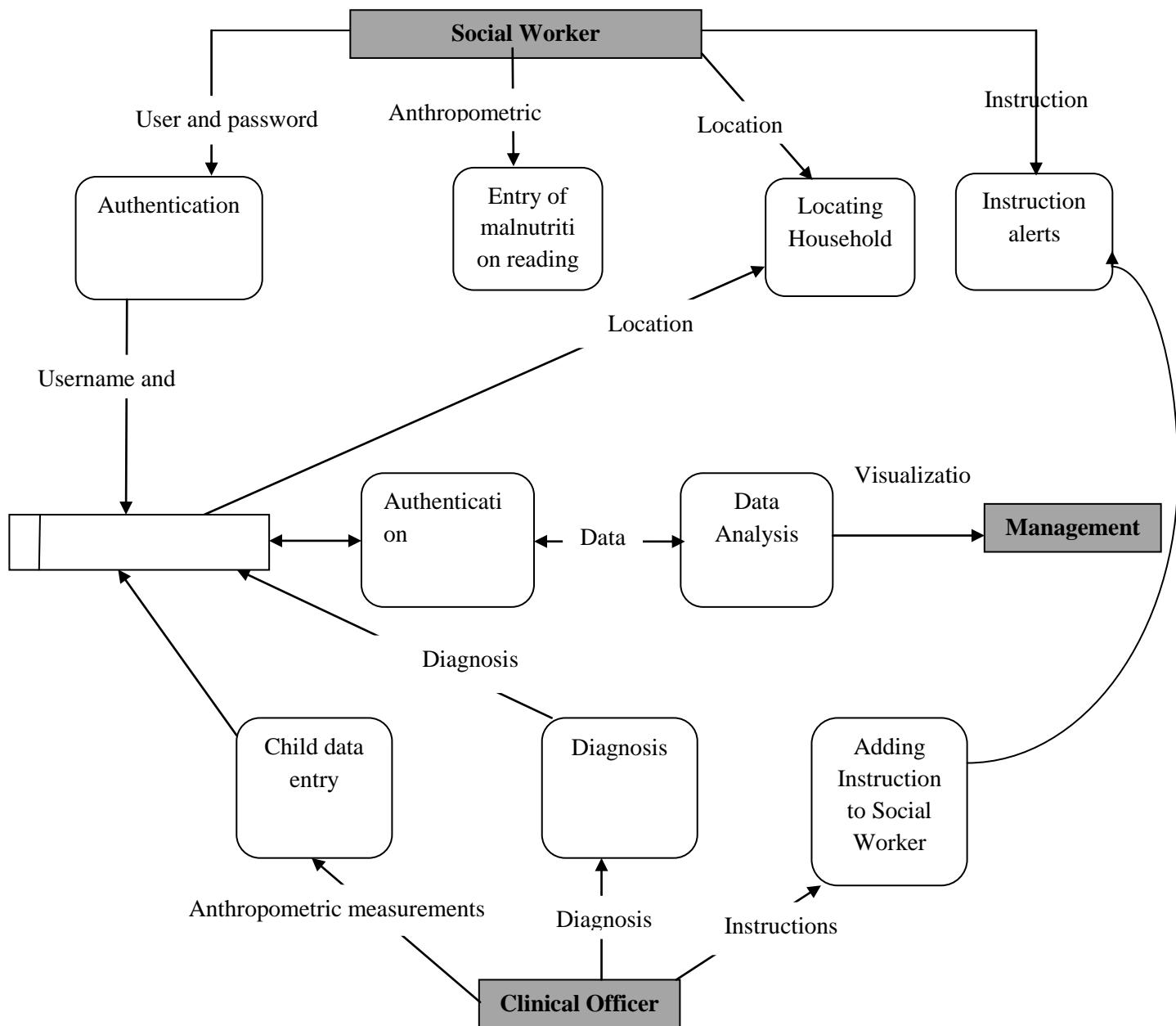
Children

21	Abubakar Salim dob: 12/10/2015
11	Mohamed Moha dob: 12/10/2015
15	Mjahid Najib dob: 12/10/2015
5	John Doe Dorian dob: 12/10/2015
4	Hassan Ali Buna dob: 12/10/2015
7	Hussein Mamo dob: 12/10/2015
9	John Doe Dorian dob: 12/10/2015
25	Najib Makartan dob: 12/10/2015

- g. Details for a child showing readings from several visits. A child details are recorded once a week for 12 week during the program.
- h. List of all the children enrolled in the malnutrition program



*Figure 9: Screen shots showing the mobile application appearing on the prototype.*



**Figure 10: The prototype architecture**

The diagram below shows the data structure of the application. It depicts how various entities and systems users interact with each other and as well as with the system.

#### **4.2.4 The network and system architecture**

- **MYSQL 5.6**

The platform would hold data entered in both the web and mobile platform. The data collected would be used by the analytics engine of the malnutrition management information system to generate trends, visualizing of the statistics and prediction of future trend. The reason for selecting this database system is its known stability, popularity and promotion of open source software.

- **Server Computer**

The prototype was designed to run on a machine that can run a 32 bit Linux operating system. This machine should have a static IP address so that it can receive data sent by mobile devices. For efficiency laptops with 1 GB RAM. The following must be installed in the machine:

- PHP server
- MYQL server
- Apache 2.2 or later
- This can be found in a WAMP/LAMP package

- **Mobile Device**

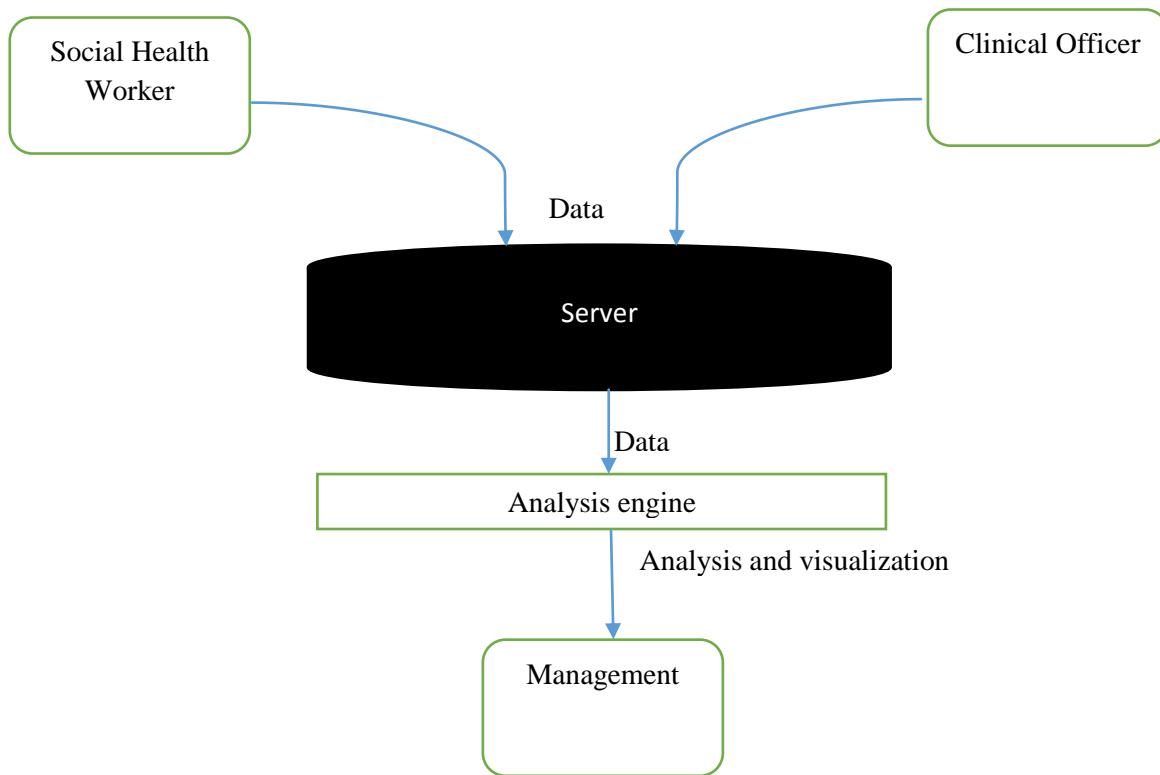
A mobile phone running on android platform: This would host the android mobile application that would be used by social workers to collect malnutrition readings in the field. The device should have the following:

- Android API 14 or later
- A screen size of 4 inches is advised

- **Network design**

Networked applications are ideal in this scenario since there is availability of well-established data networks in most refugee camps, health and social service facilities are connected via satellite, the most commonly used is **very small aperture terminal (VSAT)**.

**VSAT** uses geostationary satellites offering virtual global coverage. Communication is possible between a remote earth stations (terminals) to a master earth station called “hub” (in star configurations) or to other terminals in the group (in mesh configurations). VSAT service enables small terminals to benefit from always-on broadband connectivity. In addition to supplying a single work station or a local network, it can serve Wi-Fi hot spots or power line networks.



*Figure 11: Overview of the prototype, application developed*

## **CHAPTER FIVE**

### **5. PROTOTYPE TESTING**

The main object of this research was to find out how malnutrition management activities can be harnessed using real-time solutions to data collection analysis and decision support. At the end of analysis, a prototype was developed to demonstrate how a real-time solution can be implemented specifically in a refugee camp.

This section of the report will focus on outlining how the prototype was tested to detect faults and test conformance to specified requirements.

#### **5.1 Functional Testing**

The purpose of carrying out a functional test was to find out whether the prototype was able to deliver the requirements as defined in the proposal of this research.

The overall requirement was to research how a centralized information management system can be applied in supporting malnutrition function by allowing stakeholders working in malnutrition management programs to record, access and analyze information in real-time performance.

Base on this overall objective, a prototype was design to show how three functions involved in malnutrition management can carry out their work using such an integrated malnutrition management information system.

#### **5.1.0 Procedure that was used to conduct the functional tests.**

In order to perform the test, the following process was followed

- Decomposition of the overall objective as defined in the requirement specification
- The decomposed objectives were further broken down to test cases to allow for individual testing of each function under consideration.

#### **Below is the criteria used during the functional test.**

*Table 1: Criteria used during the functional test*

General requirements	Specific requirements	Test case
-Data collection for children suffering from malnutrition	-Registration of new babies found to be suffering in	-Add a new child in the mobile application to find out whether the system can allow a user to

	<p>malnutrition.</p>	<p>add new children.</p> <p>-Can the system detect errors when a new child is added in the system?</p> <p>-Are the registration entries relevant and exhaustive in relation to the needs of malnutrition management? Does the system include child' Bio information that is relevant to support malnutrition management</p> <p>Who has the authority to add a new child that is suffering from malnutrition to the system?</p>
	<p>-Function to allow users to record malnutrition readings for children during routine monitoring.</p>	<p>-Enter malnutrition reading to find out whether the system is able to detect discrepancy in regard to the set malnutrition criteria. The criteria applied during malnutrition reading are defined in the result section of this report.</p> <p>-Test if the system is able to compare readings from previous entries with reading in current entries.</p>

<p>-Functions to support malnutrition follow up activities.</p>	<p>-Functions to allow allocation of Vitamin and supplements to children.</p> <p>-Function to support the user in monitoring which malnutrition supplements/vitamins a child has been issued with.</p>	<p>-Test if the system can allow a user to issue supplements to a child.</p> <p>-Test if the system can display the supplement/vitamin records for each child.</p> <p>-Who can issue the malnutrition supplement? Does the system indicate the details of who has added details about malnutrition in prototype?</p>
<p>-Functions to allow multiple user working on different roles to share information regarding the population of concern</p>	<p>-Function to allow real-time update of data that is updated either in the mobile or web based system.</p> <p>- Function to allow users in different roles to perform their specific tasks into completion without being limited by the system.</p>	<p>-Add a new record to the mobile system then synchronize the application on the phone and check whether the updates are reflected on the web application.</p> <p>-Are users in the specific roles satisfied with the specific functions that are visible when using the system?</p> <p>Are users able to perform their specific tasks using the system based on the specific job needs as outlined in the requirements specifications?</p>
<p>-Function to support management of resources assigned to malnutrition programs</p>	<p>-Function to demonstrate how malnutrition resources have been allocated based on specific needs to a given</p>	<p>-At any given point, can the management see on real-time how resources have been allocated to a given population</p>

	population.	of concern?  -Can management assign specific resources to support malnutrition programs?
--	-------------	--

## **5.2 User acceptance testing**

The purpose of this test was to find out the response of staff working in malnutrition management programs towards the prototype, specific purpose of the test was as follow:

### **Below is the criteria used during the user acceptance test.**

*Table 2: Criteria used during the functional test*

General requirements	Specific requirements	Test case
-Function to allow users assigned to specific roles to effectively perform their task	<ul style="list-style-type: none"> <li>-Function to support effective monitoring of malnourished children during field visits by staff. The mobile platform is the key tool that has been designed to support field activities</li>   <li>-Dependability of the mobile platform while performing field activities</li> </ul>	<ul style="list-style-type: none"> <li>-Is the system able to assist the social worker in tracing where the child lives in order to assist the social worker make subsequent visits to the child's home for follow up?</li>   <li>-Are staff members able to learn how to work the system in a minimal time?</li>   <li>-Can the mobile application work effectively without frustrating performance of activities by staff during field visits.</li>   <li>-How easy is it to use the system in harsh conditions without compromising</li> </ul>

		delivery of service?
	<p>-Functions to support management of resources in the malnutrition management programs</p>	<p>- How easy is it to monitor resource usage my management base on day to day activities without delay in data sharing?</p> <p>-How simplified is the information available on the web platform to support management activities without them having to continuously seek help in interpreting the information.</p>

### **5.3 Testing the infrastructure**

The purpose of this test was to find out whether the prototype could function effectively in the intended environment without interrupting delivery of service to the target population. Three locations where the application was intended to work were used during this test to get the test findings.

#### **5.3.0 Testing the mobile infrastructure**

The mobile application was tested to find out its efficiency in relation to the following elements.

- Availability of network services in vast locations where refugees reside.
- Ability to synchronize information in the mobile application to that of the web application.
- Compatibility of the mobile application to particular phone specifications.

#### **5.3.1 Testing the web application infrastructure**

- Availability of network services in vast locations either at local level (camp, country level).
- Ability to synchronize information in the mobile application to that of the web application.

-Compatibility of the web application in different computing environment.

## **CHAPTER SIX**

### **6. RESULTS**

#### **6.1 Outcome of data analysis**

The aim of conducting interviews was to understand the decision making process and clearly define where the decision making process takes place during malnutrition management. A clinical officer, a health worker and a public health officer were interviewed to obtain information regarding various roles, responsibilities and data needs associated with malnutrition management.

***Table 3: Roles and responsibilities in the current malnutrition management programs.***

<b>Function Title</b>	<b>Roles/ Responsibilities</b>	<b>Data sources for this roles</b>	<b>Importance of role in Decision Support in Malnutrition Management.</b>
Clinical Officer	<ul style="list-style-type: none"><li>▪ Is a medic</li><li>▪ Prognosis of ailments</li><li>▪ Prescription of medicine</li><li>▪ <b><i>May predict malnutrition during prognosis</i></b></li><li>▪ Provides information on early warning of disease outbreak based on weekly prognosis or period assessment of persons visiting the clinics.</li></ul>	<ul style="list-style-type: none"><li>▪ Data obtained from patients during clinical tests e.g lab tests and vital examination</li><li>▪ Data provided by health workers regarding patients.</li><li>▪ Data provided by public health officers regarding general populations especially during emergencies and</li></ul>	<ul style="list-style-type: none"><li>▪ Can help by forecasting a disease outbreak before it occurs, bases on analysis of diagnosis of diseases in a given time.</li><li>▪ <b><i>Can assist in predicting occurrence of malnutrition in a patient or a</i></b></li></ul>

		outbreaks.	<i>population</i>
Public Health Officers	<ul style="list-style-type: none"> <li>▪ Manage the general health of populations of concern by assessing needs and defining suitable programs to manage health within that population.</li> <li>▪ Monitor health trends in the affected populations and identify long term measures to maintain a healthy population.</li> <li>▪ Act in supporting emergency preparedness and alerting of all parties concerned in case of a foreseen outbreak.</li> <li>▪ Prepare financial budgets to support health programs.</li> <li>▪ Seek donor funding to support health funding.</li> <li>▪ Supervise health programs and persons involved in management.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Policy documents obtained during project planning and strategic management of refugee programs.</li> <li>▪ Health related data obtained from clinical officers and health workers during day to day implementation of various health programs including malnutrition.</li> <li>▪ Health indicators obtained from health support bodies</li> <li>▪ Results of health surveys conducted in the past.</li> <li>▪ </li> </ul>	<ul style="list-style-type: none"> <li>▪ They lead in defining and implementation of malnutrition programs</li> <li>▪ They make decision which malnutrition programs will be implemented.</li> <li>▪ They make decision on how much money will be utilized in supporting malnutrition activities.</li> </ul>

	of the program.		
Health worker	<ul style="list-style-type: none"> <li>▪ Monitors general health status of the population</li> <li>▪ Follows up on identified cases of certain conditions including, malnutrition, terminal illness, pregnant and lactating mothers and elderly persons</li> <li>▪ Does field observation and day to day monitoring of health programs that are being implemented by various organizations working with refugees.</li> <li>▪ Provides support to clinical officers and public health officers by reporting health related cases that are identified or forecast during field visits.</li> <li>▪ Compiles data regarding cases that are under monitoring and shares it with various entities for</li> </ul>	<ul style="list-style-type: none"> <li>▪ Data obtained during health visits to affected populations/persons</li> <li>▪ Data regarding persons with health conditions are under treatments.</li> <li>▪ Data regarding general health trends for populations under their watch</li> <li>▪ Nutrition programs information. Type and purpose of nutrition</li> <li>▪ Data on persons under different health programs.</li> <li>▪ </li> </ul>	<ul style="list-style-type: none"> <li>▪ They are the source of all general information that is used in decision support. They collect All the malnutrition related data during field visits.</li> <li>▪ Provide details on need for intervention to the decision making team in aspects of malnutrition</li> <li>▪ They compile reports regarding malnutrition of the general population based on field observations.</li> </ul>

	<p>analysis and reporting</p> <ul style="list-style-type: none"> <li>▪ The focal point for malnutrition management.</li> </ul>		
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### **Parameters for measuring malnutrition.**

Anthropometric measures like Age, Sex, Height, length and Weight and Oedema are used to determine malnutrition. **The anthropometric measures are used to determine nutrition status of a person compared against a reference population.** References are used to compare a child's measurement(s) with the **median** for children of the **same sex and age for height for-age** and **weight-for-age, or to children of the same sex and height for weight-for height.** The internationally accepted reference was developed by the CDC and its National Center for Health Statistics (NCHS) using data collected from a population of healthy children.

The World Health Organization (WHO) adopted the NCHS reference curves for international use. **Evidence has shown that the growth patterns of well-fed, healthy preschool children from diverse ethnic backgrounds are similar and consequently are applicable for children from all races and ethnicities.** These references are used by agencies involved with nutritional assessments and analysis. These measures can also be used to determine malnutrition prevalence in a given population.

### **Calculating Malnutrition**

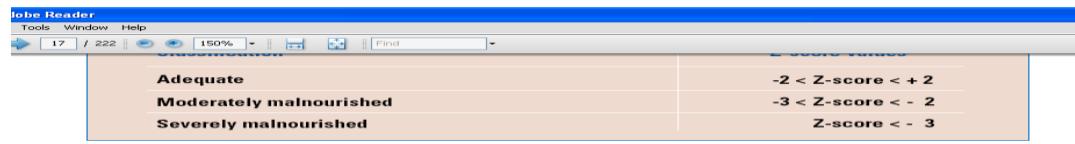
Anthropometric indices can be expressed in relationship to the reference population in two different statistical terms: Standard deviations from the median or percentage of the median.

The percentage of median is commonly used and recommended for admission/discharge criteria for selective feeding programs. Percentage of median is the ratio of the child's weight to the median weight of a child of the same height in the reference data, expressed as a percentage. Standard deviations are the preferred expression for anthropometric indicators in surveys.

This project will apply the percentage of median since the focus of the project is to continuously collect data from a given population rather than use survey methods.

**Figure 12: Calculating malnutrition.**

**Source of the figure:** A Manual: Measuring and interpreting malnutrition by WFP and CDC.



The screenshot shows a Microsoft Word document with a table titled "Table 1.2 Classification of malnutrition for weight-for-height, height-for-age, and weight-for-age based on percentage of the median". The table has four columns: Classification, Weight-for-height (%), Height-for-age (%), and Weight-for-age (%). The rows are: Adequate (90-120, 95-110, 60-80), Mildly malnourished (80-89, 90-94, -), Moderately malnourished (70-79, 85-89, 60-80), and Severely malnourished (<70, <85, <60). Above the table, there is a smaller table showing Z-score ranges for malnutrition levels: Adequate (-2 < Z-score < +2), Mildly malnourished (-3 < Z-score < -2), and Severely malnourished (Z-score < -3).

Classification	Weight-for-height (%)	Height-for-age (%)	Weight-for-age (%)
Adequate	90-120	95-110	60-80
Mildly malnourished	80-89	90-94	-
Moderately malnourished	70-79	85-89	60-80
Severely malnourished	<70	<85	<60

Example 1.3 Calculation of prevalence of wasting			
To calculate the prevalence of wasting, count all the children in the sample with a weight-for-height less than -2 Z-scores. Report the result as a percentage of the total sample.			
You measured 900 children.			
101 had a weight-for-height less than -2 Z-scores.			
The prevalence of wasting would be 101/900 or 11.2%.			

**Figure 13: Calculating malnutrition.** Source of the figure: A Manual: Measuring and interpreting malnutrition by World Food Program and Centre for Disease Control.

**Weight-for-Height Reference in Percentage of the Median for both Boys and Girls (Supine)**

Length (cm)	Median kg	Percent of median					Length (cm)	Median kg	Percent of median				
		85%	90%	75%	70%				85%	90%	75%	70%	
48.0	3.2	2.7	2.6	2.4	2.3		67.0	7.6	6.5	6.1	5.7	5.3	
48.5	3.3	2.9	2.6	2.5	2.3		67.5	7.8	6.6	6.2	5.8	5.4	
50.0	3.4	2.9	2.7	2.5	2.4		68.0	7.9	6.7	6.4	5.9	5.5	
50.5	3.4	2.9	2.7	2.6	2.4		68.5	8.0	6.8	6.4	6.0	5.6	
51.0	3.5	3.0	2.8	2.7	2.5		69.0	8.2	7.0	6.6	6.1	5.7	
51.5	3.6	3.1	2.9	2.7	2.5		69.5	8.3	7.1	6.7	6.2	5.8	
52.0	3.7	3.1	3.0	2.8	2.6		70.0	8.5	7.2	6.8	6.3	5.9	
52.5	3.8	3.2	3.0	2.8	2.6		70.5	8.6	7.3	6.9	6.4	6.0	
53.0	3.9	3.3	3.1	2.9	2.7		71.0	8.7	7.4	7.0	6.5	6.1	
53.5	4.0	3.4	3.2	3.0	2.8		71.5	8.9	7.5	7.1	6.6	6.2	
54.0	4.1	3.5	3.3	3.1	2.9		72.0	9.0	7.6	7.2	6.7	6.3	
54.5	4.2	3.6	3.4	3.2	2.9		72.5	9.1	7.7	7.3	6.8	6.4	
55.0	4.3	3.7	3.5	3.2	3.0		73.0	9.2	7.8	7.4	6.9	6.5	
55.5	4.4	3.8	3.5	3.3	3.1		73.5	9.4	8.0	7.5	7.0	6.5	
56.0	4.6	3.9	3.6	3.4	3.2		74.0	9.5	8.1	7.6	7.0	6.6	
56.5	4.7	4.0	3.7	3.5	3.3		74.5	9.6	8.2	7.7	7.2	6.7	
57.0	4.8	4.1	3.8	3.6	3.4		75.0	9.7	8.2	7.8	7.3	6.8	
57.5	4.9	4.2	3.9	3.7	3.4		75.5	9.8	8.3	7.9	7.4	6.9	
58.0	5.1	4.3	4.0	3.8	3.5		76.0	9.9	8.4	7.9	7.4	6.9	
58.5	5.2	4.4	4.2	3.9	3.6		76.5	10.0	8.5	8.0	7.5	7.0	
59.0	5.3	4.5	4.3	4.0	3.7		77.0	10.1	8.6	8.1	7.6	7.1	
59.5	5.5	4.6	4.4	4.1	3.8		77.5	10.2	8.7	8.2	7.7	7.2	
60.0	5.6	4.8	4.5	4.2	3.9		78.0	10.4	8.8	8.3	7.8	7.2	
60.5	5.7	4.9	4.6	4.3	4.0		78.5	10.5	8.9	8.4	7.8	7.3	
61.0	4.9	5.0	4.7	4.4	4.1		79.0	10.6	9.0	8.4	7.9	7.4	
61.5	6.0	5.1	4.8	4.5	4.2		79.5	10.7	9.1	8.5	8.0	7.5	
62.0	6.2	5.2	4.9	4.6	4.3		80.0	10.8	9.1	8.6	8.1	7.5	
62.5	6.3	5.4	5.0	4.7	4.4		80.5	10.9	9.2	8.7	8.1	7.6	
63.0	6.5	5.5	5.2	4.8	4.5		81.0	11.0	9.3	8.8	8.2	7.7	
63.5	6.6	5.6	5.3	5.0	4.6		81.5	11.1	9.4	8.8	8.3	7.7	
64.0	6.7	5.7	5.4	5.	4.7		82.0	11.2	9.5	8.9	8.4	7.8	
64.5	6.9	5.9	5.5	5.2	4.8		82.5	11.3	9.6	9.0	8.4	7.9	
65.0	7.0	6.0	5.6	5.3	4.9		83.0	11.4	9.6	9.1	8.5	7.9	
65.5	7.2	6.1	5.7	5.4	5.0		83.5	11.5	9.7	9.2	8.6	8.0	
66.0	7.3	6.2	5.9	5.5	5.1		84.0	11.5	9.8	9.2	8.7	8.1	
66.5	7.5	6.4	6.0	5.6	5.2		84.5	11.6	9.9	9.3	8.7	8.2	

**Figure 14: Calculating malnutrition.**

Source of the figure: A Manual: Measuring and interpreting malnutrition by World Food Program and Centre for Disease Control

This chart represents a template that is used to check malnutrition indicators for children affected by malnutrition. The health worker depends on information on the template to determine the malnutrition status of the children.

## **6.2 Result from prototype testing**

### **6.2.0 Results from the requirement and usability test**

***Table 4: Results from the requirement and usability test***

<b>Test case</b>	<b>Results of the test process</b>
<p>-Can the system detect errors when a new child is added in the system?</p> <p>-Are the registration entries relevant and exhaustive in relation to the needs of malnutrition management? Does the system include child' Bio information that is relevant to support malnutrition management</p> <p>Who has the authority to add a new child that is suffering from malnutrition to the system?</p> <p>-Add a new child in the mobile application to find out whether the system can allow a user to add new children.</p>	<p>PRO: User is able to add new babies with malnutrition on the mobile application.</p> <p>The registration process provides a process flow making it easy for the user to update information as required.</p> <p>The system only allows the social health workers to add new babies other users cannot do so.</p>
<p>-Enter malnutrition reading to find out whether the system is able to detect discrepancy in regard to the set malnutrition criteria. The criteria applied during malnutrition reading are defined in the result section of this report.</p> <p>-Test if the system is able to compare readings from previous entries with reading in current entries.</p>	<p>CON: The system was not able to detect discrepancies in regard to malnutrition thus the user has to manually follow up on this information</p>
<p>-Test if the system can allow a user to issue supplements to a child.</p> <p>-Test if the system can display the supplement/vitamin records for each child.</p> <p>-Who can issue the malnutrition supplement? Does the system indicate the details of who has added details about</p>	<p>PRO: The user both on the mobile and web application can view malnutrition instructions once issued on children affected by malnutrition.</p> <p>The system only allows the clinical officer to decide what kind of supplements can be issued to the</p>

malnutrition in prototype?	malnourished child
<p>-Add a new record to the mobile system then synchronize the application on the phone and check whether the updates are reflected on the web application.</p> <p>-Are users in the specific roles satisfied with the specific functions that are visible when using the system?</p> <p>Are users able to perform their specific tasks using the system based on the specific job needs as outlined in the requirements specifications?</p> <p>How often does a user have to request for information from counter parts when performing his work to facilitate service delivery.</p>	<p>PRO:-The system allows the user to record malnutrition readings on the mobile platform and by synchronization the information is transferred to the web application.</p> <p>Both the clinical office and the social health worker can perform roles that are assigned to them while depending on shared data that is available on the web application and the mobile application at real-time basis.</p> <p>CON:- The need to synchronize the data however was observed as a cause for delay which could lead to errors during reporting if the team involved in data collection forgets to synchronize the dat.</p>
<p>-At any given point, can the management see on real-time how resources have been allocated to a given population of concern?</p> <p>-Can management assign specific resources to support malnutrition programs?</p>	<p>PRO: Management team can easily access reports regarding malnutrition by viewing summary information that is available on the web based system. The reports are available both as charts and narratives.</p>
<p>-Is the system able to assist the social worker in tracing where the child lives in order to assist the social worker make subsequent visits to the child's home for follow up?</p> <p>-Are staff members able to learn how to work the system</p>	<p>CON:- The system has tried to implement maps that can be used to pin the location of every child to enable tracing. This however could not be properly implemented using</p>

<p>in a minimal time?</p> <p>-Can the mobile application work effectively without frustrating performance of activities by staff during field visits.</p> <p>-How easy is it to use the system in harsh conditions without compromising delivery of service?</p>	<p>the mobile application. This requirement was not met in the system</p> <p><b>PRO/CON:</b> The mobile app would require an effective network and mobile platform (cell phone) to facilitate its functionality. Only two locations were tested for efficiency. More test need to be done to ascertain efficiency of it service on average.</p>
<p>- How easy is it to monitor resource usage my management base on day to day activities without delay in data sharing?</p> <p>-How simplified is the information available on the web platform to support management activities without them having to continuously seek help in interpreting the information.</p>	<p><b>PRO:-</b> The management can allocate resources and monitor resource usage online depending on the need of every camp or specific population that is under consideration.</p>

## **CHAPTER SEVEN**

### **7. CONCLUSION**

#### **Introduction**

The aim of this research was to find out how a Management Information System can be used to enhance service delivery in malnutrition programs within refugee camps. A prototype MIS was also to be developed to show how malnutrition management can be enhanced by using better data collection analysis and reporting methods. The prototype was also tested in a real refugee setting to identify anomalies and areas of improvement for the research. This section of the report gives a brief summary of the research process.

#### **The objective of the research:**

The general objective of the research was to assess the application of management information systems in supporting malnutrition management activities by improving the process of recording, sharing and accessing information for decision support. Based on the research, a web based and mobile application was found to be ideal to support malnutrition management activities.

#### **Outcome of the research:**

The research led to the development of both a mobile and web based application. After testing these two platform, it was found that some of the issues raised during malnutrition management activities could be eliminated by allowing users to update, analyze, share and view information without depending on physical input from other users. Some of the issues that the MIS would solve include.

#### **Recommendation to improve the prototype**

-The system could eliminate information dependency of different roles that currently have share information in order to perform their tasks. Since every user has an opportunity to update and manage information on a shared platform, the emphasis would be to make sure that user have

access to the platform required to update information that is the mobile and web app. Users would also need to be well trained to ensure that they maintain discipline when updating information especially for mobile users. Synchronization of information would have to be done at every entry to ensure that information is sent to the central system where all users can access the information.

-These platform (web and mobile) would also need an effective network service to ensure users are not disconnected when using the systems especially for those users located in vast areas. The network would also need to be reliable to ensure that there is data security and no data loss during transmission of information.

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## **APPENDIX**

### **Questionnaire for collecting feedback**

#### **Questionnaire for collecting feedback regarding your experience while using the malnutrition management Information System prototype:**

**Brief description:-**The Malnutrition Management Information System is designed to demonstrate how malnutrition management activities can be enhanced by implementing a malnutrition management information system.

**Purpose of the questionnaire: -** This questionnaire is designed to collect feedback from selected persons working in malnutrition management program. The aim is to get users' views on their experience while using the prototype and their assessment on whether the system can effectively support malnutrition management activities.

**Description of the system:** The prototype is designed to include two platforms:

- Mobile platform: The platform is designed to allow registration of malnutrition entries and recording routine reading during malnutrition visits.
  - The installation kit for the mobile platform has been sent to you through email and instructions on how to install it on your phone
  - Please install it and use the credentials provided in the email to access and use the application.
- The web platform is designed to allow recording of clinical recordings and to allow management to view malnutrition reports.
  - The web application is available through the link provided in your email. Please use the credentials availed to access the site.

***NB: Please feel free to contact me in case of any issues.***

#### **Section 1: Feedback regarding your experience:**

- A. **How would you rate the systems efficiency during data collection (recording of malnutrition readings)?**

**Table 5: Sample template for the questionnaires**

Opinion	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The data entry platform is easy to navigate without seeking help					
The system provides a proper flow of malnutrition activities as represented in the real world.					
It is easy to make errors when recording malnutrition readings					
The system functions are easy to access and interpret when recording data					
The system performance speed is good enough to allow real-time data entry and access to previously added information					
The system is secure enough to prevent authorized users from adding and accessing information in the system.					
It is easy to use the application to collect data compared to the current method that is being used in data collection.					
I would recommend this system to be used in					

supporting malnutrition management activities					
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**B. How would you rate the system's ability to avail information required in malnutrition management?**

Opinion	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
The system provide a fast access to information that I need during malnutrition management and monitoring					
Information availed in the system is mostly accurate and a representative of the real world scenario					
It is easy to access the information regardless of location challenges					
The information is presented in easy to interpret formats which make it easy for decision support.					
Reports availed in this system are easy to use and understand compared to the current reporting methods.					
I would not recommend this system to be used in malnutrition management					

activities					
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C. How would you rate the system in regard to it's practicality in supporting malnutrition function?

Opinion	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I would like to use this system when conducting malnutrition activities.					
I would require a lot of training before gaining confidence to use this system.					
There are too many inconsistencies in the systems.					
Whenever I made mistakes it was easy to recover from the errors.					
The system was easy to install and use on my phone.					
The web portal was easy to access					